Digital Image Processing Homework 5

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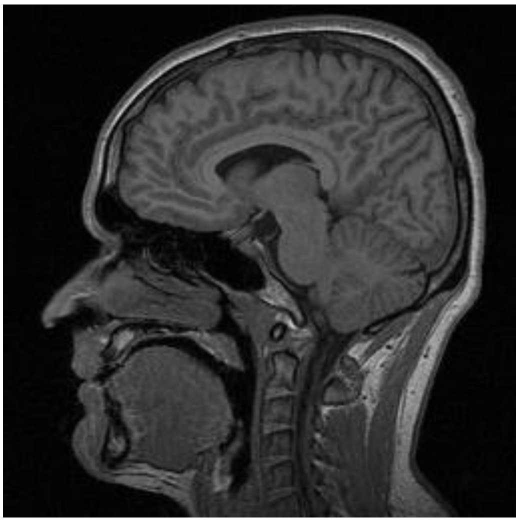
4**(a)**

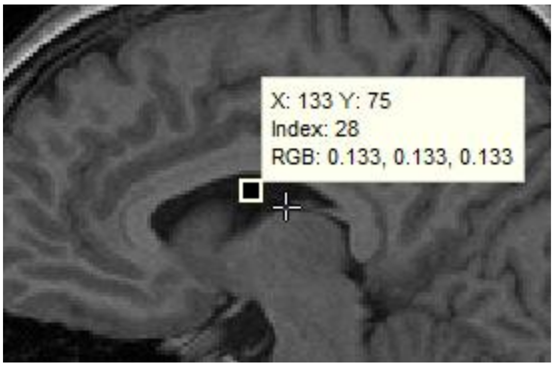
The brain image is below

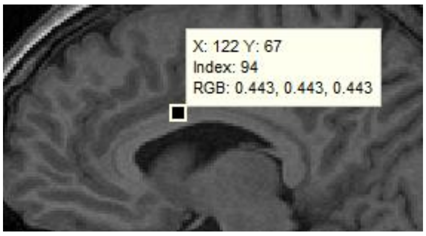


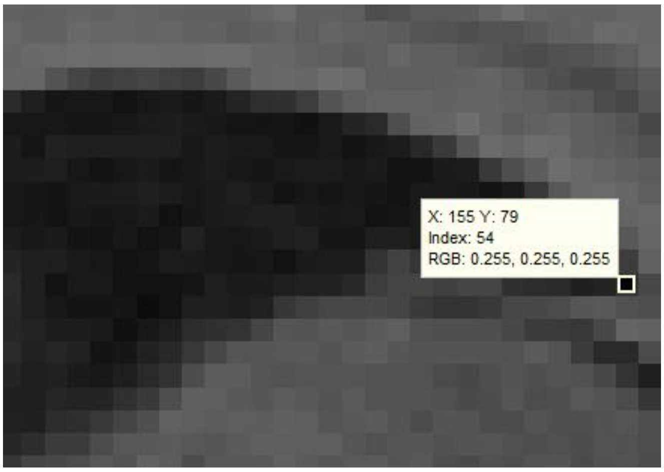
So the color of the ventricles is dark. We can set a threshold, any point whose intensity is below this threshold should be detected as ventricle, any point whose intensity is above this threshold should be detected as not ventricle.

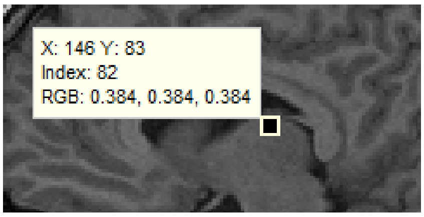
To get the accurate threshold, we sample different pixels and find out the intensity. The threshold should make sure that nearly all of the points in ventricle should be detected, but the surrounding area of ventricle should never be detected. For other parts of the image, it doesn't matter whether we have detection error only if it isn't connected with ventricle part.

Here are some samples:



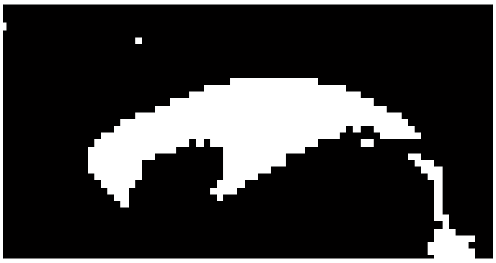






So according to the observation and experiment, set threshold to 56 is close to the best.

threshold =56



enlarge the ventricle part

All the ventricle parts are successfully detected and also other parts near ventricle are not detected, which fulfills the requirements.

(b) First we set A equals the detected area(threshold image), B equals the 8-connectivity mask. X_0 is the original image that all of the points are background points except one point which is seed point in (132, 76). X_i is the i-th iteration, the iteration would stop if $X_i=X_{i-1}$.

$X_i=(X_{i-1}\oplus B)\cap A$

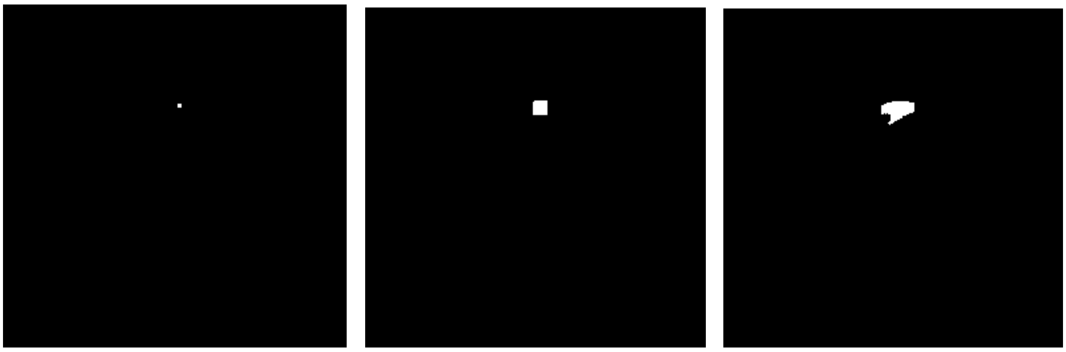
X would spread to neighbor points(8-connectivity) that locate in A.

In programming, first we write dilation function according to the formula

$A\oplus B=\{z\,|\,(\widehat{B})_z\cap A\neq\emptyset\}$

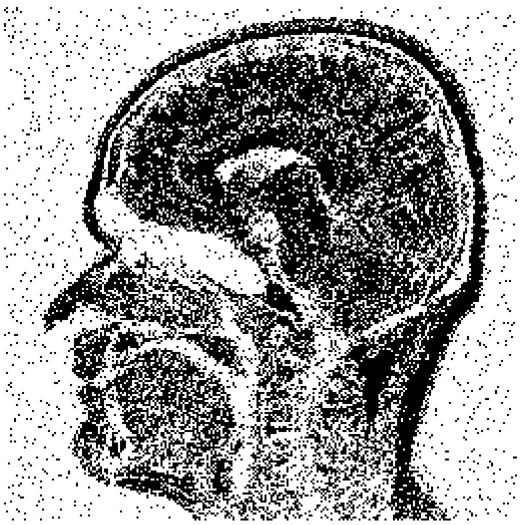
Then we use formula $X_i=(X_{i-1}\oplus B)\cap A$ to iterate until $X_i=X_{i-1}$.

We can always pause to watch the temporal results.

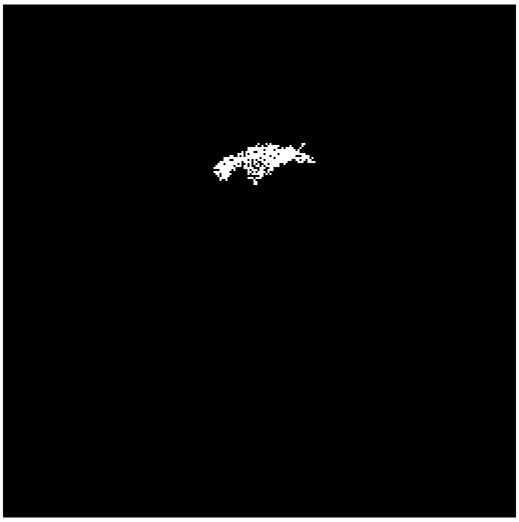


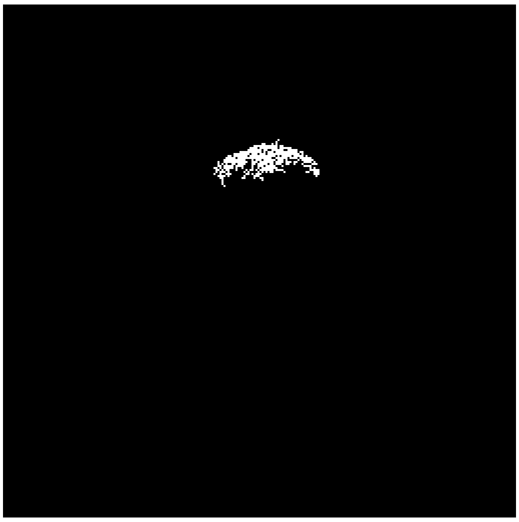
final results

(c) After adding noise, the image would looks like below



The result is

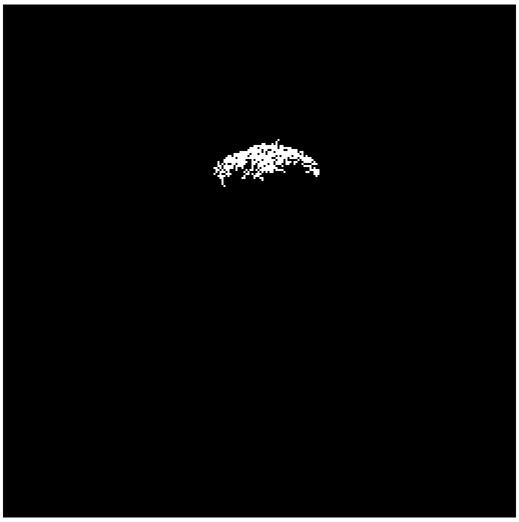


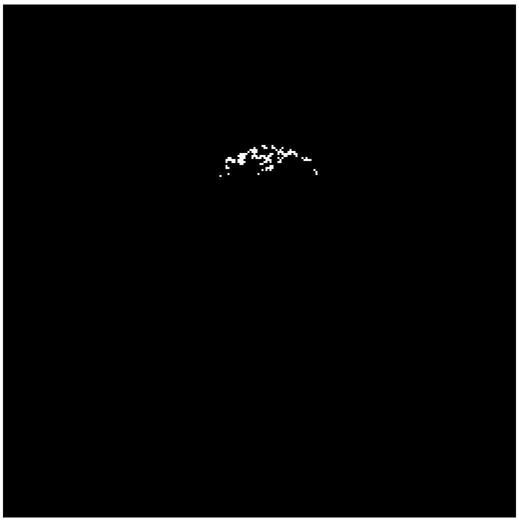


Results(first experiment) Results(second experiment)

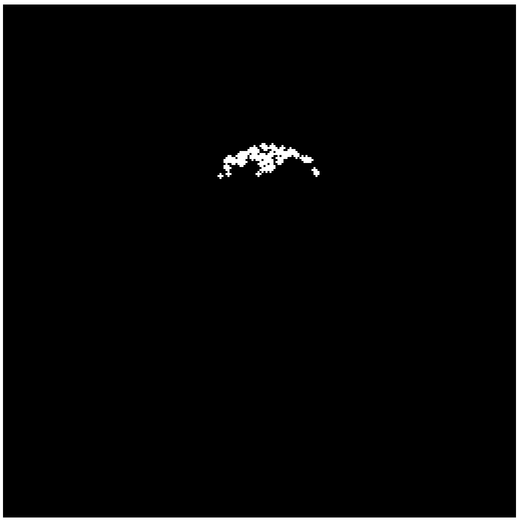
So the results are not so accurate. Some ventricle points are not detected but some background has been detected by mistake. It is not a good segmentation.

We do the denoising by opening and closing, which equals to doing erosion, then dilation, then dilation, and then erosion. We treat results as input and write dilation and erosion function to apply this.(use 4-connectivity)

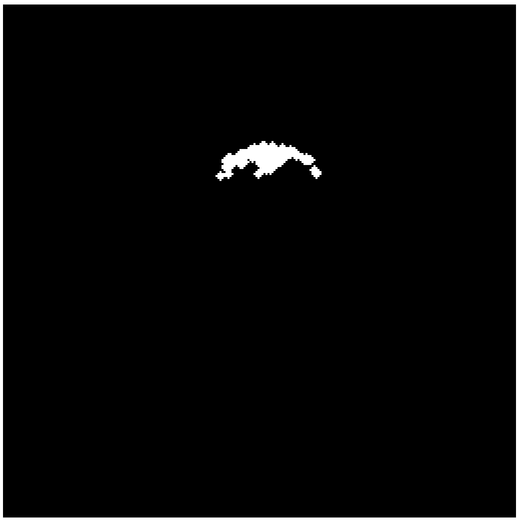




Result without denoising erosion



erosion+dilation



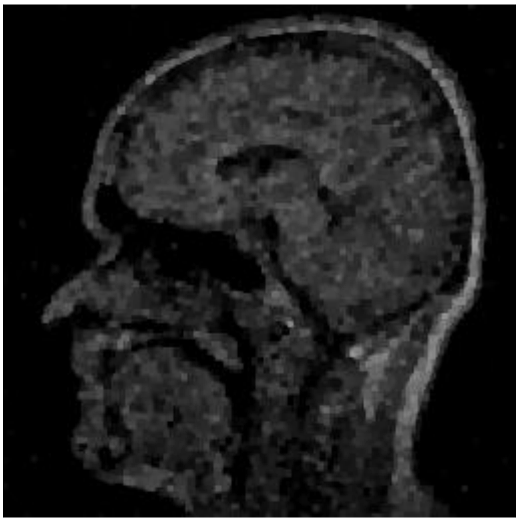
erosion+dilation+dilation

denoising image(erosion+dilation+dilation+erosion)

So after denoising, no noise appears in the image. The result is much better than without denoising.

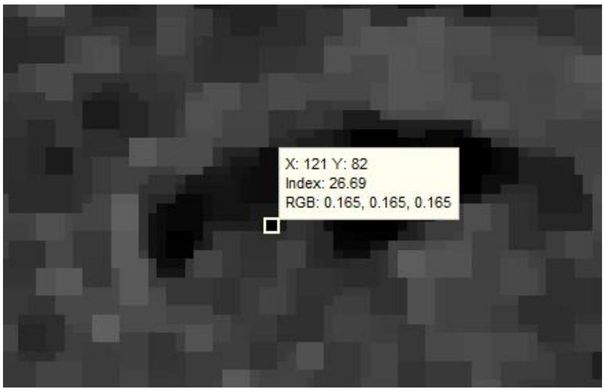
Method 2

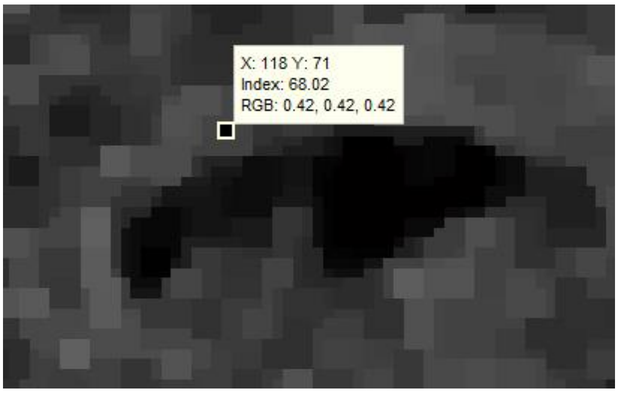
We can also do the Gray-scale morphology---smoothing by opening and closing. Before set threshold for segmentation, we smooth the noisy image by Gray-scale opening and closing.
The Gray-scale erosion is $[f\ \theta\ b](x,y)=\min\{f(x+s,y+t)\}$
The Gray-scale dilation is $[f \oplus b](x,y)=\max\{f(x-s,y-t)\}$
The opening is erosion and then dilation, the closing is dilation and then erosion.
So we do erosion, dilation, dilation and then erosion, and get the following results.



noisy image noisy image after opening and closing

Then we sample some intensity to get best threshold.





According to observation and experiment, set threshold equals to 33 is close to the best. After doing segmentation, we get the following image

Segmentation image

Then we use the same algorithm of region growing to get the final result:

denoising image

As we can see, the denoising image is much better than without denoising, because after denoising, nearly all of points in ventricle are detected, and its surroundings are not detected area, which is easy to be separated.